

WHAT IS CLAIMED IS:

1. An image forming method comprising a step of reacting a droplet of an aqueous ink with a liquid composition on a recording medium, the ink containing a coloring material in a monomolecular state and the liquid composition containing fine particles reactive with the coloring material, wherein the step comprises: a process where the coloring material reacts with the fine particles in a liquid comprised of the droplet and the liquid composition;

a process where the coloring material is adsorbed onto surfaces of the fine particles keeping the monomolecular state in the ink; and

a process where the fine particles which have adsorbed the coloring material aggregate each other.

2. An image forming method comprising a step of conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition on a recording medium, the ink containing a coloring material and the liquid composition containing fine particles reactive with the coloring material, wherein the step comprises:

a process where the coloring material is adsorbed by the fine particles on surfaces thereof while maintaining the monomolecular state in the ink; and

a process where the fine particles which have

adsorbed the coloring material aggregate each other.

3. An image forming method comprising a step of conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition on a recording medium, the ink containing a coloring material in a monomolecular state and the liquid composition containing fine particles reactive with the coloring material, wherein the step comprises:

a process where the fine particles near a constituent surface of the recording medium are physically or chemically adsorbed on the constituent surface of the recording medium;

a process where the coloring material is adsorbed by the fine particles on surfaces thereof while maintaining the monomolecular state in the ink; and

a process where the fine particles which have adsorbed the coloring material aggregate each other.

4. An image forming method comprising a step of conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition, the ink containing a coloring material in a monomolecular state and the liquid composition containing fine particles reactive to the coloring material, wherein the step comprises:

a process where the coloring material is adsorbed

on surfaces of the fine particles at an interface between the droplet and the liquid composition while keeping the monomolecular state in the ink; and

5 a process where the fine particles which have adsorbed the coloring material aggregate each other.

5. An image forming method comprising a step of conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition, the ink
10 containing a coloring material in a monomolecular state and the liquid composition containing fine particles reactive to the coloring material, wherein the step comprises:

15 a process wherein the coloring material diffuses into the liquid composition to be adsorbed on the surfaces of the fine particles while keeping the monomolecular state; and

20 a process where the fine particles having adsorbed the coloring material on the surface thereof aggregate each other.

6. An image forming method comprising a step of conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition, the ink
25 containing a coloring material in a monomolecular state and the liquid composition containing fine particles reactive to the coloring material, wherein the step

comprises:

a process where the coloring material is adsorbed on the surfaces of the fine particles while keeping the monomolecular state in the vicinity of an interface
5 between the droplet and the liquid composition;

a process where the coloring material diffuses into the liquid composition to be adsorbed on the surfaces of the fine particles while keeping the coloring material in the monomolecular state; and

10 a process where the fine particles having adsorbed the coloring material on the surface thereof aggregate each other.

7. An image forming method comprising a step of
15 conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition on a recording medium, the ink containing a coloring material in a monomolecular state and the liquid composition containing fine particles reactive to the
20 coloring material, wherein the step comprises:

a process the fine particles in the vicinity of a constituent surface of the recording medium are physically or chemically adsorbed on the constituent surface of the recording medium;

25 a process where the coloring material is adsorbed on the surfaces of the fine particles while keeping the monomolecular state, in the vicinity of an interface

between the droplet and the liquid composition;

a process where the coloring material diffuses into the liquid composition to be adsorbed on the surfaces of the fine particles while keeping the monomolecular state; and

a process where the fine particles having adsorbed the coloring material on the surface thereof aggregates each other.

8. An image forming method comprising a step of conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition, the ink containing a coloring material in a monomolecular state and the liquid composition containing fine particles reactive to the coloring material, wherein the step comprises:

a process where the fine particles in the vicinity of a constituent surface of the recording medium aggregate each other on the constituent surface of the recording medium;

a process where the coloring material is adsorbed on the surfaces of the aggregates of the fine particles while keeping the monomolecular state;

a process where the fine particles and the coloring material in the vicinity of an interface between the droplet and the liquid composition contact each other and the coloring material is adsorbed on the

surfaces of the fine particles while keeping the monomolecular state;

5 a process where the coloring material diffuses into the liquid composition to be adsorbed on the surfaces of the fine particles while keeping the monomolecular state;

10 a process where a dispersion state of the fine particles becomes unstable due to the adsorption of the coloring material on the surfaces thereof, and the fine particles aggregate each other; and

15 a process where the fine particles having adsorbed or bound the coloring material on the surfaces thereof are fixed to the surface of the recording medium.

20 9. An image forming method comprising a step of conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition on a recording medium, the ink containing a coloring material in a monomolecular state and the liquid composition containing fine particles which are reactive to the coloring material and aggregate as a distance between particles becomes short, wherein the step comprises:

25 a process where the fine particles in the vicinity of a constituent surface of the recording medium aggregate each other on the constituent surface

of the recording medium;

a process where the coloring material is adsorbed on or bonded to surfaces of the aggregates of the fine particles while keeping the monomolecular state;

5 a process where the fine particles in the vicinity of an interface between the droplet and the liquid composition come into contact with the coloring material to adsorb or bond the coloring material while keeping the monomolecular state of the coloring
10 material;

a process where the coloring material diffuses into the liquid composition to be adsorbed on or bonded to surfaces of the fine particles while keeping the monomolecular state;

15 a process where the fine particles having adsorbed the coloring material on the surfaces thereof aggregate each other; and

a process the fine particles and aggregates thereof having adsorbed or bonded the coloring material
20 on the surfaces thereof are fixed to the surface of the recording medium.

10. The image forming method according to any one of Claims 1 to 9, wherein the aggregation of the
25 fine particles having adsorbed the coloring material is attributable to the absorption of the coloring material on the surfaces of the fine particles.

11. An image forming method comprising a step of conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition on a recording medium, the ink containing a coloring material in a monomolecular state, the liquid composition containing fine particles reactive to the coloring material, wherein the step comprises:

a process where the fine particles in the vicinity of a fiber surface of the recording medium are physically or chemically adsorbed on the fiber surface; a process where the coloring material is adsorbed on surfaces of the fine particles in the vicinity of an interface between the droplet and the liquid composition while keeping the monomolecular state;

a process where the coloring material diffuses into the liquid composition to be adsorbed on surfaces of the fine particles while keeping the monomolecular state;

a process where the fine particles aggregate each other due to the adsorption of the coloring material on the surfaces of the fine particles; and

a process where the fine particles having adsorbed the coloring material on the surfaces thereof are fixed to the surface of the recording medium.

12. The image forming method according to Claim

11, wherein the fine particles are electrochemically adsorbed on the recording medium to enhance the liquid-liquid reaction on the recording medium.

5 13. An image forming method comprising a step of conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition on a recording medium, the ink containing a coloring material in a monomolecular state, and the liquid
10 composition containing fine particles reactive to the coloring material, wherein the step comprises:

 a process where the fine particles in the vicinity of a fiber surface of the recording medium are physically or chemically adsorbed on the fiber surface;

15 a process where a pool of the liquid composition is formed on the recording medium;

 a process where the coloring material is adsorbed on the surfaces of the fine particles in the vicinity of an interface between the droplet and the pool of the
20 liquid composition while keeping the monomolecular state;

 a process where the coloring material diffuses into the liquid composition to be adsorbed on surfaces of the fine particles while keeping the monomolecular
25 state;

 a process where the fine particles aggregate themselves due to the adsorption of the coloring

material on the surfaces of the fine particles; and
a process where the fine particles having
adsorbed the coloring material on the surfaces thereof
are fixed to the surface of the recording medium.

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14. The image forming method according to any
one of Claims 1 to 9, 11 and 13, wherein an ink-jet
recording method is used.

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15. The image forming method according to any
one of Claims 1 to 9, 11 and 13, wherein the ink is
anionic or cationic.

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16. The image forming method according to any
one of Claims 1 to 9, 11 and 13, wherein the material
is anionic or cationic.

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17. The image forming method according to any
one of Claims 1 to 9, 11 and 13, wherein the ink is
anionic or cationic, and the fine particles have a
polarity opposite to the ink.

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18. The image forming method according to any
one of Claims 1 to 9, 11 and 13, wherein the ink
contains the coloring material being anionic or
cationic, and the fine particles have a polarity
opposite to the ink.

19. An image forming method comprising the steps of reacting a droplet of an aqueous ink containing a coloring material with a liquid composition containing fine particles reactive to the coloring material on a recording medium; and causing the coloring material to be uniformly adsorbed in a monomolecular state on the surfaces of the fine particles.

20. An ink set comprising an anionic or cationic aqueous ink containing a coloring material, and an aqueous liquid composition containing a compound reactive to the aqueous ink wherein specific gravities of the aqueous ink and the liquid composition are different from each other.

21. The ink set according to Claim 20, wherein the aqueous ink is lighter than the liquid composition in specific gravity.

22. The ink set according to Claim 20, wherein the aqueous ink is heavier than the liquid composition in specific gravity.

23. An ink-jet recorded image comprising a colored portion which contains fine particles having a coloring material in a monomolecular state on surfaces thereof, wherein a saturation in CIE-L*a*b* space at a

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BHH
428/95
23-36, 31,
50, 51

106/31.27, 31.6
106/31.33, 31.65

solid printed area of the colored portion is 50.

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A1
Cont'd

27. A ink-jet recorded image formed by a coloring material and fine particles reactive to the coloring material, wherein the coloring material is present more than the fine particles at a peripheral part of a main image forming part of a colored portion.

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D1

28. The ink-jet recorded image according to any one of Claims 23 to 27, wherein the coloring material is anionic or cationic, and the fine particles have a polarity opposite to the coloring material.

29. The ink-jet recorded image according to Claim 28, wherein the fine particles have such a surface potential that an absolute value of a zeta potential in an aqueous liquid composition in which the fine particles are dispersed is 5 to 90 mV.

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D2

20 30. The ink-jet recorded image according to any one of Claims 23 to 27, wherein the average particle diameter of the fine particles is within a range of from 0.005 to 1 μ m.

25 31. The ink-jet recorded image according to any one of Claims 23 to 27, wherein the image is of plural colors.

32. The ink-jet recorded image according to

Claim 31, wherein the plural colors are at least two colors selected from the group consisting of yellow, magenta, cyan, red, green, blue and black.

5 33. A recorded article having an image
comprising a colored portion on a recording medium,
wherein the image comprises at least one of fine
particles and aggregates of fine particles, at least
one of the fine particles and the aggregates of fine
10 particles adsorb a coloring material in a monomolecular
state on the surfaces thereof, and at least one of the
fine particles and the aggregates of fine particles
come into contact with the surface of a constituent of
a recording medium through the coloring material.

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 34. A recorded article comprising at least one
of fine particles and aggregates of fine particle, on
the surfaces of which a coloring material has been
adsorbed in a monomolecular state, said fine particles
or aggregates being present on the surface of a
20 recording medium in the form of aggregate mass
partially containing voids.

25 35. A recorded article having an image
comprising a colored portion on a recording medium,
wherein the colored portion includes a first region
mainly containing at least one of fine particles and

aggregates of fine particles, on the surfaces of which a coloring material has been adsorbed in a monomolecular state, and a second region located outside the first region and mainly containing the coloring material.

36. A recorded article comprising, on the surface of a recording medium, a recorded portion containing at least one of fine particles and aggregates of fine particle, on the surfaces of which a recording agent has been adsorbed in a monomolecular state.

37. An ink set independently comprising an ink containing a coloring material, and a liquid composition containing fine particles reactive to the coloring material, wherein the ink and the liquid composition are such that when they are mixed with each other, the coloring material is adsorbed on or bonded to the surfaces of the fine particles while keeping a molecular state as in the ink, whereby the dispersed state of the fine particles is made unstable to cause aggregation of the fine particles themselves.

38. An ink set independently comprising an ink containing a coloring material, and a liquid composition containing fine particles reactive to the

coloring material, wherein the ink and the liquid composition are such that when they are mixed with each other, monomolecules of the coloring material are adsorbed on or bonded to the surfaces of the fine particles, whereby the dispersed state of the fine particles is made unstable to cause aggregation of the fine particles themselves.

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39. A surface-treated article characterized in that the surface of the article has at least one of fine particles and aggregates of fine particle, the surfaces of the particles a functional substance has been adsorbed in a monomolecular state.

40. A surface treating method for imparting a functionality to a base material, the method comprising the steps of:

bringing a first liquid composition containing a functional substance and a second liquid composition containing fine particles reactive to the functional substance into contact with each other in a liquid state; and

causing the functional substance to be evenly adsorbed in a monomolecular state on the surfaces of at least one of the fine particles and aggregates of the fine particles.

41. An image forming method comprising a step of reacting an ink with a liquid composition on a recording medium, the ink containing a coloring material and the liquid composition containing fine particles reactive to the ink, wherein the step comprises:

a process where the coloring material is adsorbed on or bonded to the surfaces of the fine particles or aggregates of the fine particles at least on the surface of the recording medium or at the vicinity thereof; and

a process where the fine particles or the fine particle aggregates having adsorbed the coloring material on the surface thereof, are fixed to the surface of the recording medium or the vicinity thereof.

42. An image forming method comprising a step of conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition on a recording medium, the ink containing a coloring material and the liquid composition containing fine particles reactive to the coloring material, wherein the step comprises:

a process where the coloring material is adsorbed or bonded in a monomolecular state to the surfaces of the fine particles or aggregates of the fine particles

at least on the surface of the recording medium or at the vicinity thereof; and

5 a process where the fine particles or the fine particle aggregates, on the surfaces of which the coloring material has been adsorbed, are fixed to the surface of the recording medium or the vicinity thereof.

10 43. An image forming method comprising a step of conducting a liquid-liquid reaction between a droplet of an aqueous ink and a liquid composition, the ink containing a coloring material and the liquid composition containing fine particles reactive to the coloring material, wherein the step comprises:

15 a process where the fine particles in the vicinity of a constituent surface of the recording medium are physically or chemically adsorbed on the constituent surface;

20 a process where the coloring material is adsorbed or bonded in a monomolecular state to the surfaces of the fine particles or aggregates of the fine particles at least on the surface of the recording medium or at the vicinity thereof; and

25 a process where the fine particles or the fine particle aggregates, on the surfaces of which the coloring material has been adsorbed, are fixed to the surface of the recording medium or the vicinity

thereof.

44. An image forming method comprising a step of
conducting a liquid-liquid reaction between a droplet
5 of an aqueous ink and a liquid composition, the ink
containing a coloring material and the liquid
composition containing fine particles reactive to the
coloring material, wherein the step comprises:

a process where the fine particles aggregate
10 themselves in the vicinity of a constituent surface of
the recording medium on the constituent surface;

a process where the coloring material is adsorbed
or bonded to the surfaces of the fine particles or
aggregates of the fine particles in a monomolecular
15 state at least on the surface of the recording medium
or at the vicinity thereof; and

a process where the fine particles or the fine
particle aggregates, on the surfaces of which the
coloring material has been adsorbed, are fixed to the
20 surface of the recording medium or the vicinity
thereof.

45. An image forming method comprising a step of
conducting a liquid-liquid reaction between a droplet
25 of an aqueous ink and a liquid composition, the ink
containing a coloring material in a monomolecular state
and the liquid composition containing fine particles,

which fine particles are reactive to the coloring material and aggregate by mixing with the ink, on a recording medium, wherein the step comprises:

5 a process where the fine particles in the vicinity of a constituent surface of the recording medium aggregate on the constituent surface;

a process where the coloring material is adsorbed on or bonded to the surfaces of aggregates of the fine particles while keeping the monomolecular state;

10 a process where the fine particles in the vicinity of an interface between the ink and the liquid composition come into contact with the coloring material to adsorb or bond the coloring material to the surfaces of the fine particles while keeping the monomolecular state of the coloring material;

15 a process where aggregation of the fine particles on the surfaces of which the coloring material has been adsorbed occurs; and

20 a process where the fine particles and fine particle aggregates, on the surfaces of which the coloring material has been adsorbed or bonded, are fixed to the surface of the recording medium.

46. The image forming method according to any
25 one of Claims 41 to 45, which further comprises a process where the ink and the liquid composition come into contact with each other, and diffuse into each

er to form a mixed liquid, and a process wherein coloring material is adsorbed or bonded in a molecular state to the fine particles of the liquid.

47. The image forming method according to claim 46, wherein the process where the ink and the liquid composition come into contact with each other and diffuse into each other comprises a process where a part of the liquid composition is formed on the recording medium, and a process where the ink and the liquid composition comes into contact with each other.

48. The image forming method according to claim 46, wherein the process where the ink and the liquid composition come into contact with each other and diffuse into each other comprises a process where a part of the ink is formed on the recording medium, and a process where the pool of the ink comes into contact with the liquid composition.

49. The image forming method according to claim 46, wherein the fine particles and fine pigments are fixed to the recording medium before the coloring material.

50. A recorded article having a color image formed on a recording medium by the image forming method according to claim 46.

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formed on a recording medium, the colored portion containing at least one of fine particles and aggregates of fine particle, on the surfaces of which a coloring material has been adsorbed in a monomolecular state, wherein at least one of the coloring material and the fine particles has penetrated into an inside of the recording medium.

51. A recorded article comprising a colored portion formed on a recording medium, the colored portion containing at least one of fine particles and aggregates of fine particle on the surfaces of which a coloring material has been adsorbed in a monomolecular state, wherein the coloring material and the fine particles has penetrated into the inside of the recording medium, and at least part of the penetrated coloring material is adsorbed or bonded to the penetrated fine particles in a monomolecular state.